ROOTSTOCK INFLUENCES EARLY FRUITFULNESS, GROWTH, AND SURVIVAL IN LOBLOLLY PINE GRAFTS

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Abstract.--Scions from three loblolly pine clones were grafted on loblolly, slash, shortleaf, pond, and spruce pine rootstocks; and their performance was evaluated for 4 years. Scions on spruce pine roots grew more slowly and fruited earlier than those on other rootstocks, but their survival rate was poorer. Overall performance was best on slash pine roots. Rootstock had no effect on vegetative or reproductive phenology.

Additional keywords: Phenology, incompatibility, clone, Pinus taeda.

In most improvement programs for southern pine, grafted orchards are established from plus-tree scions. Much care is exercised in selecting scions, but surprisingly little consideration is given to the rootstock. In the study described here, rootstocks affected fruitfulness, growth, and graft compatibility in loblolly pines (Pinus taeda L.).

For more than a century rootstocks have been selected to enhance early production and to control size in fruit trees (Sax 1958). Recently Ahlgren (1962, 1972) found that in certain northern Pinus species rootstock not only influences strobili production and survival but also occasionally affects reproductive phenology. Research with shortleaf pines (P. echinata Mill.) showed that rootstock influences fruitfulness but not reproductive phenology (Schmidtling 1969, 1971).

MATERIALS AND METHODS

The ramets in the experimental orchard are scions from three loblolly clones, each grafted onto seedlings of loblolly, shortleaf, slash (P. elliottii Engelm. var. elliottii), spruce (P. glabra Walt.), and pond (P. serotina Michx.) pines. The three ortets are located in a 14-year-old plantation in southern Mississippi; they vary widely in size and fruitfulness, but have all flowered.

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Scions were top-cleft grafted on potted seedling rootstocks in January 1969. A total of 198 grafts were made, 13 or 14 of each of the 15 scion/rootstock combinations. In late May 1969, grafts were outplanted on the Harrison Experimental Forest at 15- by 15-foot spacing in a completely random design with single-tree plots.

Heights were measured and strobili counted annually. Ramets showing signs of incompatibility such as scion overgrowth or yellowing were considered non-survivors. Terminal bud elongation was measured three times a week from spring 1970, when growth began, until summer 1970, when growth ceased. In the springs of 1972 and 1973, female strobili were scored for receptivity two or three times a week during flowering. Strobili counts were normalized with the sq. root of x+1 transformation. Differences in mean heights and strobili counts were tested by analysis of variance. Survival differences by rootstock were tested by chi-square. All statistical tests were at the 0.05 level of probability.

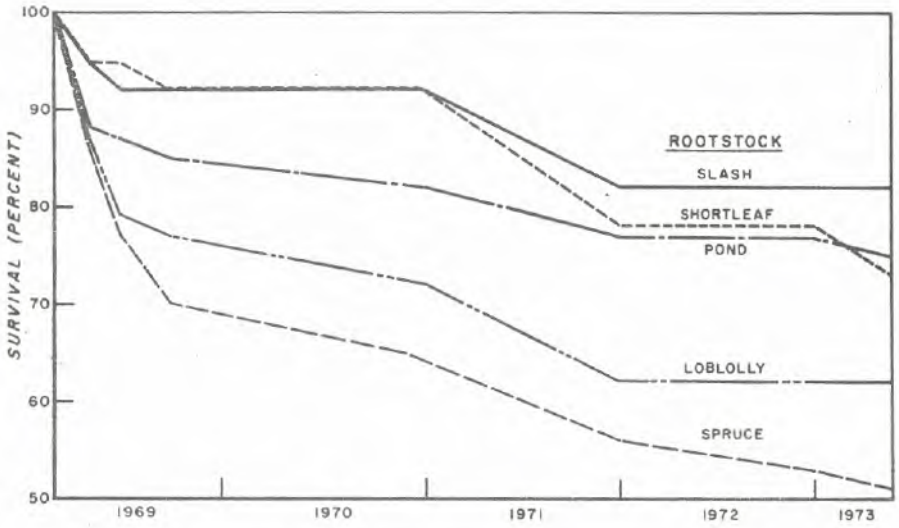

Figure 1.--Survival by rootstock of three loblolly pine clones grafted on five southern pine rootstocks.

RESULTS AND DISCUSSION

Survival

Initial graft take averaged above 90 percent and differed little between clones or rootstocks. By the winter after outplanting, considerable mortality had occurred (fig. 1). Currently, survival ranges from 82 percent on slash rootstock to 51 percent on spruce pine. Mortality in clones 2 and 3 was very light and varied little among rootstocks. Clone I suffered considerable loss due to incompatibility, and only 41 percent

of the ramets survived. Over 80 percent of the total mortality since outplanting resulted from losses in this clone. Unlike clones 2 and 3, survival in clone 1 varied considerably between rootstocks, with poorest results on spruce pine roots. Such findings are perhaps not surprising since spruce pine is not as closely related phylogenetically to the scion species as are the other rootstocks. If phylogenetic similarity is important, however, one would expect the best survival on loblolly rootstock. Actually, clone 1 survived best on slash rootstock (73 percent), with loblolly rootstock running a poor fourth (36 percent).

Although these survival data are preliminary, they do support conclusions derived from an 11-year study documenting improved survival of loblolly scions on slash rootstock (Schmidtling and Scarbrough 1970).

Height Growth

As anticipated, height growth differed significantly among clones. More importantly, heights differed significantly among rootstocks every year after outplanting (fig. 2). Initially growth was best on slash rootstock, averaging 38 cm. the first year as compared to only about 23 cm. for all other combinations. This superiority soon disappeared. The most striking difference now apparent is the relatively small size of the scions on spruce pine rootstock (2.5 m.) in comparison with the others, which range from 2.9 m. for pond pine to 3.1 m. for shortleaf pine rootstock.

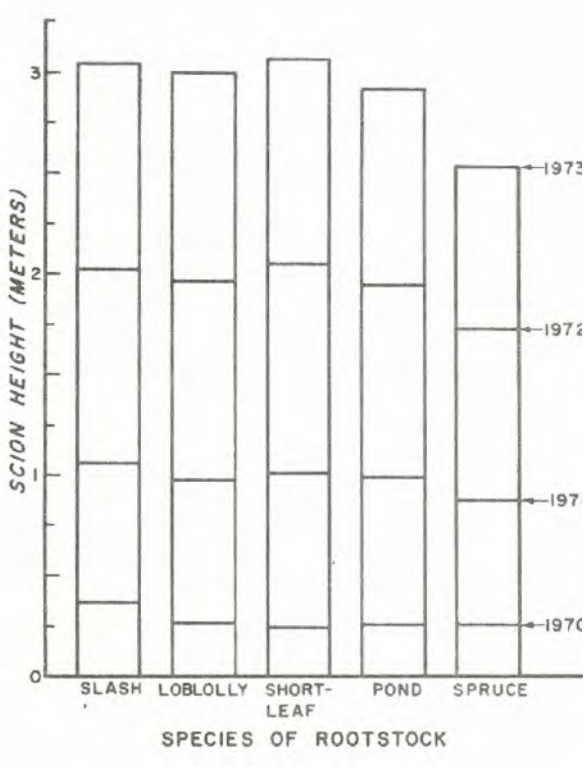

Figure 2.--Height growth of three loblolly pine clones grafted on five southern pine rootstocks.

Allen (1967) also found significant differences in height growth 5 years after loblolly seedling scions were grafted on loblolly, slash, and shortleaf rootstocks. His height differences were larger than mine, probably because of the seedling origin of his scion material.

The rootstock x clone interaction was not significant, indicating that the rootstocks had approximately the same effect on the height growth of all clones.

Fruitfulness

Rootstocks significantly affected numbers of female strobili produced in 1970 and 1972. The rootstock x clone interaction was never significant. Surprisingly, there were enough strobili for analysis in 1970 after only 1 year in the field. For the first 3 years, production was consistently best on spruce pine rootstock (table 1). The homoplastic combination (scion and rootstock of the same species) performed

poorly, and in 1972 the number of strobili per ramet on loblolly roots (2.4) was about half the number on spruce pine (4.7). Previous work with other Pinus species has also shown that heteroplastic grafts are generally more fruitful than homoplastic ones (Schmidtling 1969, Ahlgren 1972).

Table 1.--Female strobili produced by three loblolly pine clones on five southern pine rootstocks

Rootstock	Year			
	1970	1971	1972	1973
	Female strobili per tree			
Slash	0.19	0.03	3.56	45.1
Loblolly	0.07	0.08	2.42	40.4
Shortleaf	0	0.07	1.71	37.8
Pond	0.06	0.03	2.93	37.9
Spruce	0.68	0.33	4.68	29.4

In 1973, an extremely good year for female strobilus production in loblolly pines in south Mississippi, spruce pine-rooted ramets dropped from first to last place. Slash pine took the lead, with 45 strobili per ramet as compared to 40 for loblolly and 29 for spruce pine. The differences among rootstocks were not statistically significant. Apparently rootstock has a relatively minor effect in a year when a bumper crop of strobili is produced.

Clonal effects were significant every year except 1971. Clone 2, always the best producer, averaged 80 strobili per ramet in 1973. Clone 1 bore an average of 28 strobili per ramet in 1973. Clone 3 did not produce any strobili until 1972 and averaged only 8 strobili per ramet in 1973. Based on the performance of the ortets, fruitfulness was expected to be lowest in clone 1 rather than in clone 3. Clone 1's surprising fertility could be yet another manifestation of incompatibility since ramets often flower well under stress.

Phenology

No difference in vegetative phenology could be related to either rootstock or clone of scion. The elongation of the first flush was remarkably uniform. Variation developed in subsequent flushes, especially the third and fourth (when present); but no meaningful pattern was evident in initiation, duration, or number of flushes.

A distinct clonal effect was observed in female strobili development, but rootstock did not influence reproductive phenology in 1972 or 1973. Receptivity among rootstocks within an individual clone was very uniform.

Apparently rootstock does not affect phenology in loblolly pines as it does in Pinus cembra (Ahlgren 1972). Similarly, rootstock has little effect on the reproductive phenology of shortleaf pine (Schmidtling 1971).

CONCLUSIONS

Rootstock obviously influences height growth and fruitfulness in loblolly pines. In the past, loblolly was commonly grafted on slash rootstock for good take and vigorous early growth; but this practice was discontinued because of concern over possible incompatibility and effects on reproductive phenology. These fears now seem groundless. Loblolly scions survived and fruited better on slash than on loblolly roots, and rootstock had no effect on phenology. In fact, slash pine rootstock may be helpful in circumventing incompatibility. Since initial survival is best on this rootstock, its use could enable a tree breeder to complete controlled crosses and to retain a clone in a breeding program which would otherwise be lost.

Whether spruce pine rootstock is a good choice for loblolly scions is still questionable. Survival of one clone was especially poor on this rootstock. The induced early fruitfulness would be of value in a breeding program, and the smaller size could facilitate cone collection in a mature orchard. However, final evaluation can only be made when long term data on survival, growth, and fruitfulness are available.

LITERATURE CITED

Ahlgren, C. E. 1962. Some factors influencing survival, growth, and flowering of intraspecific and interspecific pine grafts. J. For. 60: 785-789.

Ahlgren, C. E. 1972. Some effects of inter- and intraspecific grafting on growth and flowering of some five-needled pines. Silvae Genet. 21: 122-126.

Allen, R. M. 1967. Influence of the root system on height growth of three southern pines. For. Sci. 13: 253-257.

Sax, K. 1958. Experimental control of tree growth and reproduction. In The physiology of forest trees, p. 601-610. K. V. Thiman (ed.) N. Y.: Ronald Press.

Schmidtling, R. C. 1969. Influence of rootstock on flowering in shortleaf pine. Tenth South. For. Tree Improv. Conf. Proc., p. 229-230.

Schmidtling, R. C., and Scarbrough, N. M. 1970. Observations on phenology and reproductive performance of interspecific grafts of loblolly pines. First North Am. For. Biol. Workshop, p. 38. (Abstr.)

Schmidtling, R. C. 1971. Geographic races of shortleaf pine not reproductively isolated in a mixed plantation. Eleventh South. For. Tree Improv. Conf. Proc., p. 212-217.